§2. Sustainment of High Stored Energy in ICRF Heating

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To reduce the radiation loss from oxygen and carbon and to keep them in low level are key issues for ICRF heating. Boronization is one of the useful technique for this purpose.

In initial experiments without boronization, it was found that ICRF heating was useful as a plasma heating method. Then helium glow discharge cleaning and titanium gettering were done frequently for vacuum wall conditioning. Increase in the stored energy of 650J was observed when RF power was applied to the ECH afterglow plasma. The period of effective heating was about 20msec, which was limited by the impurity radiation. Various impurity lines (OV, CIII, TiXII, etc.) were observed by the VUV spectroscopy, and it was found that the plasma performance was mainly affected by the oxygen radiation.

Boronization was done for wall conditioning. Vaporized decaborane ($B_{10}H_{14}$) was injected into helium glow discharge at pressure of about 40mtorr through 4 valves. Following boronization increase in the stored energy lasted to the end of the heating pulse. The radiation loss from oxygen impurity was reduced by more than 2 times. Using P-port antennas RF power of 250kW produced a 1kJ plasma and this stored energy was sustained by ICRF heating alone. U-port antenna has similar characteristics, i.e. RF power of 240kW produced a 1.4kJ plasma and sustained it till the end of the heating pulse. Figure 1 shows the time evolution of the total injected RF power, averaged electron density, radiation loss power, diamagnetic stored energy, electron temperature on the magnetic axis measured with Thomson scattering and ion temperature measured with the Neutral Particle energy Analyzer (NPA) when RF power was applied simultaneously to the U-port antenna and P-port antennas[1]. The plasma stored energy reached 2.2kJ with 600kW of RF power and an averaged electron density of $4.2 \times 10^{13} cm^{-3}$. For this discharge the radiation power was kept below 200kW. The hydrogen minority ratio H/(H+D) measured spectroscopically was about 30% in spite of the pure deuterium gas puffing. The recycling particle from the boronized wall was mainly hydrogen. The electron temperature on the magnetic axis was almost constant during the RF pulse (300eV). The ion temperature measured with NPA was about 300eV at the beginning of the RF pulse and decreased gradually. Finally the ion temperature became lower than that of the electron. It seems that the large part of RF power heats the electron. The mode conversion of the fast wave to the ion Bernstein wave or/and the direct electron heating by the fast wave may occur. The detail of heating mechanism is under investigation.

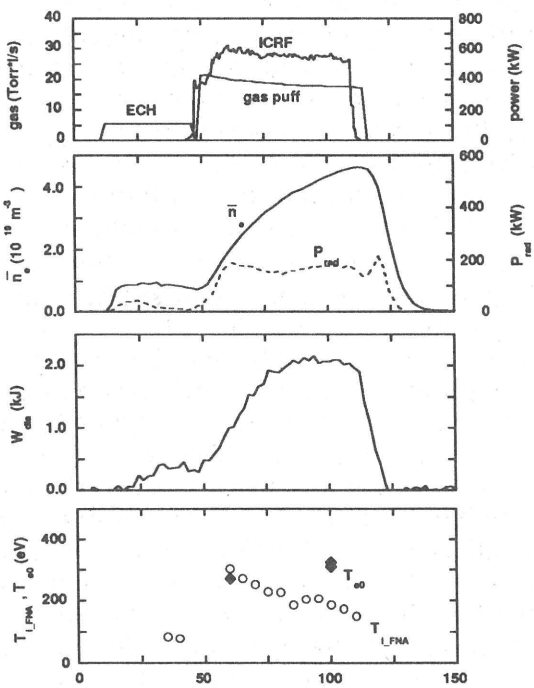

Fig. 1. Time evolution of plasma parameters.

Reference

1) K. Nishimura, et al., 15th IAEA Conf., Seville, 1994 (IAEA, Vienna, 1994) IAEA-CN-60 /A-6-I-4.